Fire Hazard Analysis
Building 901A
Tandem Van De Graaff

Brookhaven National Laboratory

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Date of Last Survey:	March 29, 2004
Date of Report:	June 2007

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TABLE OF CONTENTS

1.0 OVERVIEW AND RECOMMENDATIONS

1.1 Purpose and Methodology

A Fire Hazard Analysis (FHA) was performed for Building 901A, the Tandem Van De Graaff Facility at the Brookhaven National Laboratory (BNL), Upton, NY. This report fulfills the requirement for documentation of an FHA as outlined in DOE Order 420.1, Facility Safety. This FHA assesses the risk from fire in Building 901A to ascertain whether the facility meets the objectives of DOE Order 420.1 and the Brookhaven National Laboratory (BNL) Fire Safety Program. The fundamental goal of the BNL Fire Safety Program is to control fire risks such that:

1. Public and employees are not unreasonably endangered by fire;
2. Vital Laboratory missions are maintained without significant interruption from fire;
3. Property losses are limited to less than $1 million dollars per occurrence, and lower when justified by cost-effective, risk reduction measures;
4. Damage to the environment is averted; and
5. The potential for occurrences of fires are avoided whenever economically feasible.

This FHA is an evaluation of the fire hazards (1) that expose Building 901A and (2) that are inherent in the building or operations. The adequacy of the fire safety features in the building and the degree of compliance of the facility with specific fire safety provisions in DOE orders, and related engineering codes and standards, were determined. The results of the analyses are presented in terms of the fire hazards present, the potential extent of fire damage, and the impact on employee and public safety.

The general approach taken to complete this evaluation involved the identification of fire hazards in the building and the fire protection features required to mitigate the adverse consequences of a fire. A determination was made as to the adequacy of the proposed fire protection features to effectively control the fire hazards. Concerns for the protection of safety systems, critical processes, and life safety of building occupants from fire were essential considerations in the analysis. Compliance was determined by a comparison of existing conditions found during the site visits with current code requirements. Where conflicting requirements were found the more conservative requirements were used in this evaluation.

Pictures #1 and #2 – Building 901A

The MPFL scenario was based on a qualitative consideration of several factors; the potential to reach flashover conditions based on combustible loading and the geometry of the space(s) under consideration; adequacy of passive protection features; and continuity of combustibles.

The MCFL scenario is one in which automatic suppression systems function as designed. Since properly designed and installed sprinkler systems should limit the fire growth and/or damage to the design area of the system, this floor area is used in the determination of MCFL potentials when protected by automatic sprinkler systems. Without sprinkler protection the MCFL is the same as the postulated MPFL for that area.

MPFL and MCFL potentials were determined based on an average dollar density of the building replacement value divided by the floor area of the building. Building values were obtained from 2004 replacement costs. The content and equipment values were calculated based on the following assumptions:

- An average of $20/ft^2 for content and equipment value within predominantly office or support areas.
- An average of $100/ft^2 for content and equipment value within the industrial and experimental areas of the building, assuming no high dollar equipment present.

The above cost assumptions are considered adequately conservative to address the requirement to include decontamination and cleanup costs.

A qualitative assessment of the risk presented by conditions found to be deficient was also performed and is included in Section 1.3, Findings and Recommendations. This assessment was made by assignment of a risk assessment code (RAC). The RAC methodology is used in a number of industries as a tool to qualitatively prioritize deficiencies and corrective actions and is derived as follows:

1. <u>Hazard Severity</u>. An assessment of the worst potential consequence, defined by degree of occupational injury, illness or property damage which is likely to occur as a result of the deficiency. Hazard severity categories shall be assigned by roman numerals according to the following criteria:

   a. Category <u>I</u>. May cause death, permanent total disability, or loss of a facility/asset.

   b. Category <u>II</u>. May cause permanent partial disability, temporary total disability in excess of 90 days (severe injury or severe occupational illness), or major property damage.

   c. Category <u>III</u>. May cause minor injury, occupational illness, or property damage.

   d. Category <u>IV</u>. Presents minimal threat to personnel safety or health, or property, but is still in violation of a standard.

2. <u>Mishap Probability</u>. The probability that a hazard will result in a mishap or loss, based on an assessment of such factors as location, exposure (cycles or hours of operation), affected populations, experience, or previously established statistical information. Mishap probability shall be assigned an English alphabet symbol according to the following criteria:

a. Subcategory A. Likely to occur immediately or within a short period of time. Expected to occur frequently to an individual item or person or continuously to a fleet, inventory or group.

b. Subcategory B. Probably will occur in time. Expected to occur several times to an individual item or person or frequently to a fleet, inventory or group.

c. Subcategory C. May occur in time. Can reasonably be expected to occur some time to an individual item or person or several times to a fleet, inventory or group.

d. Subcategory D. Unlikely to occur.

3. Risk Assessment Code. Using the matrix shown below, the RAC is expressed as a single Arabic number that is used to help determine hazard abatement priorities.

Hazard Severity	**Mishap Probability**			
	A	**B**	**C**	**D**
I	1	1	2	3
II	1	2	3	4
III	2	3	4	5
IV	3	4	5	6

RAC Definitions

1-Critical
2-Serious
3-Moderate
4-Minor
5 & 6-Negligible

1.2 Summary

Building 901A, the Tandem Van De Graaff facility provides pre-injection to the colliders and accelerators at the BNL. The building was operational in 1970 and is 65,611 square feet. The Van De Graaff generators/accelerators are referred to as Duoplasmatron Negative Ion Sources.

The descriptions are based on field surveys, a review of the as-built documents, and discussions with BNL staff. This assessment and FHA demonstrates general achievement of a reasonable and equivalent level of fire safety, except as noted within this document that meets DOE improved risk objectives.

Overview of the BNL

This Fire Hazards Analysis (FHA) has been performed to comprehensively assess the risk from fire in Building 901A, the Tandem Van De Graaff. The FHA includes an analysis of the fire and life safety features of the facility to determine the level of compliance with DOE Order 420.1 Fire Protection objectives.

Based on the analysis, it has been determined that Building 901A is not in compliance with DOE Order 420.1 Fire Protection objectives. The following recommendations are the result of this evaluation.

1.3 Findings and Recommendations

1.3.1 New Findings and Recommendations

Finding: The doors at the main entrance to the accelerator room from the control room are not fire rated.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Recommendation HAI-07-901A-01: The existing doors should be replaced with listed or approved doors of a 1 ½ hour rating. (See Section 4.3.1)

Finding: The cable trays in the tunnel like area between the accelerator room and the computer and control rooms present a special fire hazard due to the difficulty of accessing the area.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Recommendation HAI-07-901A-02: Automatic sprinkler protection should be provided for the cable trays in the tunnel like area between the accelerator room and the computer and control rooms. (See Sections 5.1.3 and 6.1.7)

Finding: A single fire could impact both accelerators for an excessive period of time.

Hazard Severity	II
Mishap Probability	C
Risk Assessment Code	3

Recommendation HAI-07-901A-03: A contingency plan should be developed which outlines the steps required to reroute the beam line from the accelerator number 6 directly to the Tandem to Booster tunnel, thus bypassing accelerator number 7 completely. In addition, the contingency plan should address the work required to upgrade the performance of accelerator number 6 so that it is capable of independently providing particle beams to the RHIC program. The contingency plan should be capable of being implemented within six months, or at a time period acceptable to the Program Senior Official. If the six month conversion time (or time approved by the Program Senior Official) is not possible, consideration should be given to providing a permanent connection directly from accelerator number 6 to the Tandem to Booster tunnel and upgrading the performance capabilities of the accelerator. Completion of this recommendation will result in a series/parallel connection from the accelerators to the Tandem to Booster tunnel. (See Section 7.4):

Finding: The automatic sprinklers in the basement are not interconnected with the standpipe located in the office section.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Recommendation HAI-07-901A-04: The standpipe system in the office should be interconnected to the sprinkler system located in the basement. Additionally the additional fire department connection should be removed once the interconnection is complete. (See Section 5.1.3)

Finding: There is an unprotected opening between Building 901A and Building 901.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Photograph #3– Unprotected Opening

Recommendation HAI-07-901A-05: The opening should be sealed with a listed/approved fire barrier product, listed/approved for this type of penetration. (See Section 4.3.1)

The following is a summary of recommendations and their relative priority.

Rec.No.	Recommendation	RAC
HAI-07-901A-1	Fire doors from control room to accelerator room	4
HAI-07-901A-2	Protection of cable trays with automatic sprinklers	4
HAI-07-901A-3	Accelerator contingency plan	3
HAI-07-901A-4	Standpipe and sprinkler interconnection	4
HAI-07-901A-5	Unprotected opening between 901 and 901A	4

1.3.2 Outstanding Recommendations from Previous Reviews

Factory Mutual

FMR74-901A-2 Open cable trays more than one high should be provided with tight fitting bottoms constructed of non-combustible material such as asbestos board (wording from the original FM recommendation, clearly this is currently not acceptable) or sheet metal. Polyvinyl chloride filled bags filled with vermiculite should be placed in the trays at no more than 30 ft. intervals, providing a cover at least two bags in length. This protection should be provided in the basement of Building No. 901-A and in cable trenches leading to the experimental areas.

Note: The vermiculite bags are currently provided, but the cable tray bottoms are not provided with a non-combustible material.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

FMR74-901A-7 Automatic sprinklers should be installed in the entire lab office area related with the research Van De Graaff, and Tandem Van De Graaff, and Rooms 102 to 106 associated with the 60-inch Cyclotron. (Refer to Section 5.1.3)

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

2.0 SCOPE

This FHA is based on information supplied by the Accelerator Department staff, a survey of the facility conducted in May 2007, and a review of available drawings.

The following codes and standards were utilized for this evaluation:

The Building Code of New York State 2002 Edition (BCNYS)

International Code Council (ICC), International Building Code (IBC) 2003 Edition;

ICC, International Fire Code (IFC) 2003 Edition

National Fire Protection Association (NFPA) Codes, Standards, and Recommended Practices – See Section 9 (Reference Documents) of this report for a complete list.

3.0 LOCATION

Building 901A is located in the central region of Brookhaven National Laboratory (BNL). BNL is a 5,000 acre site owned by the Department of Energy and operated by Brookhaven Science Associates. BNL is located in Upton, New York.

4.0 CONSTRUCTION

4.1 Occupancy Classification

Building 901A, the Tandem Van De Graaff Building is classified by the BCNYS as a mixed occupancy consisting of “Business” and “Factory Industrial F-2 Low Hazard”.” NFPA 101 (3.3.168.10) classifies this buildings as “Mixed” occupancy.

4.2 Construction Type

The building consists of masonry and concrete walls and concrete roof with approximate floor dimensions of 450 feet by 100 feet. Much of the structure is set into a side of a hill. Interior walls are concrete block or gypsum board on steel studs. The foundation is poured concrete. The floor is concrete on unprotected steel.

The building construction type is BCNYS Type IIA and NFPA Type II (000).

The primary combustible loading in the building consists of the tandem Van De Graaff generators (accelerators), target rooms and a laboratory. There is also power and control wiring for the accelerators. Overall combustible loading was acceptable throughout the building, which the exception of a few offices that have high combustible loading.

Life Safety Code

The LSC does not specify a minimum construction type for existing special purpose industrial occupancies [§39.1.6; §40.1.6]. Thus, the existing construction complies with LSC requirements.

Building Code of New York State

Section 503 and Table 503 of the BCNYS contain criteria for the allowable height and area of buildings based on their occupancies and construction type.

The BCNYS permits an increase in allowable areas for buildings that have more than 25 percent of their perimeter on a public way or open space having a minimum width of 20 feet [IBC, §506.2]. The area increase due to frontage is determined in accordance with the following equation:

$$I_f = 100[F/P - 0.25]\ W/30, \text{ where:}$$

I_f = Area increase due to frontage.

F = Building perimeter which fronts on a public way or open space having 20 feet open minimum width (feet).

P = Perimeter of entire building (feet).

W = Width of public way or open space (feet). The width (W) must be at least 20 feet and W/30 cannot exceed 1.0.

Building 901A is 65,611 square feet, which is not within the base allowable area of 37,500 square feet for Type IIA, thus it is necessary to apply the increase for public way:

I_f = 100[1100/1100 - 0.25] 30/30

I_f = 75%

Table 4.2-1. Allowable Height and Areas for BCNYS Group F-2

	Group F-2	
	Type IIA	Type IIB*
Base Height	**65 ft** **5 stories**	55 ft 3 stories
Base Area (ft^2)	**37,500**	23,000
Modified Area (ft^2) based on public way increases	**65,625**	40,250

*Shown for illustration/comparison purposes only

International Building Code

Based on an F2 occupancy and Type II-A construction, Table 503 of the IBC permits the maximum allowable area to be 37,500 square feet and a height of 5 stories. Since Building 901A is 65,611 square feet, which is not within the base allowable area of 37,500 square feet, it is necessary to apply the increase for public way.

Section 506 and 507 of the IBC contain allowable area increases based on the location of the building and sprinkler protection, if provided. The areas limited by Table 503 can be increased due to frontage and automatic sprinklers based on the following:

$A_a = A_t + [A_t I_f / 100] + [A_t I_s / 100]$

Where:

A_a = Allowable area per floor

A_t = Allowable floor area per Table 503

I_f = Area increase due to frontage (percent) as calculated in accordance with 506.2

I_s = Area increase due to sprinkler protection (percent) as calculated in accordance with Section 506.3.

$I_f = 100[F/P - 0.25]\ W/30$

Where:

I_f = Area increase due to frontage

F = Building perimeter which fronts on a public way or open space having 20 feet open minimum width

P = Perimeter of entire building

W = Width of public way

Based on the frontage increase in accordance with Section 506.2, the resulting area increase is 75%, which results in an allowable area of 65,625 square feet, which is greater than the existing building size of 65,611 square feet.

4.3 Passive Fire Protection

Passive fire protection features include fire-resistive construction, fire doors, fire windows, and fire and smoke dampers. The features are provided to limit fire spread and damage from the area of fire origin to other portions of the building.

4.3.1 Fire Areas

Building 901A is separated from Building 901 by a masonry wall and 3-hour rated listed fire door. There is also a 1 ½ hour listed fire door between Building 901A and the modular building; Building 901M. The fire barrier wall between Building 901 and Building 901A has an unsealed penetration (see Recommendation HAI-07-901A-05). A recommendation has also been submitted, HAI-07-901A-01, to replace the existing doors from the control room to the accelerators with 1 ½ hour rated fire doors.

Building 901A complies with the codes of record with respect to occupancy separations. There are no areas in this facility that are defined as incidental or accessory occupancy use areas as noted in BCNYS "§302.1.1" or NFPA 101 §6.1.14.1.2 and "§6.1.14.1.3."

A fire area is defined as a portion of a building that is bounded by a combination of fire-resistive walls and floor/ceiling assemblies, and/or exterior walls. In DOE facilities, fire areas are typically provided for property protection. The Implementation Guide for DOE Order 420.1 requires credited fire areas to be separated from the remainder of the building by a minimum of 2-hour fire barriers (walls and horizontal assemblies). Fire areas may also be provided for compliance with building code limitations for building additions.

5.0 FIRE PROTECTION

Existing fire protection systems that provide protection to full or segmented portions of this facility can be classified in four categories; Automatic Fire Suppression Systems, Fire Alarm, Automatic Detection Systems, and Fire Extinguishers. The following is a description of the existing installed systems in the building.

5.1 Automatic Fire Suppression Systems

5.1.1 Site Water Supply

BNL has a combination domestic and fire protection water supply system. The system is supplied by several deep wells and is stabilized by two elevated water storage tanks (one 1 million gallon and one 300,000 gallon capacity). The wells have electric primary drivers and a limited number have backup internal combustion drivers. The system can sustain three days of domestic supply and a maximum fire demand (4,000 gallons per minute (GPM) for 4 hours) for BNL with two of the system's largest pumps out of service and one storage tank unavailable. The piping distribution network is well gridded. The distribution system in the vicinity of Building 901A has a static supply pressure of approximately 57 pounds per square inch (PSI) at low elevated tank levels; and approximately 70 psi normally. The water supply system in the area can supply about 5,500 GPM at 20 PSI (based on the Water Distribution Model Analysis developed by the Fire Protection Engineering Group during the summer of 2004.)

Frost proof Fire hydrants are provided within 300 ft of the entrances of the building. Frost proof hydrants are needed since the frost line extends to 4 feet below the surface in the winter. BNL and the local Suffolk County Fire Departments use National Standard Thread couplings.

BNL's Plant Engineering Division maintains the water supply system. BNL's Fire/Rescue Group conducts valve inspections on the distribution system to ensure reliability of firefighting water supplies.

5.1.2 Building Water Supply and Fire Department Connection

Building 901A is generally not provided with automatic sprinklers. The building has two 6-inch black steel mains connected to a 10-inch main along East Cornell Street. One service main is for the sprinkler system located in the basement and enters at the southwest corner of the building. The second main supplies the standpipe system and enters in the south central basement area. Both mains are provided with 6-inch post indicating gate valves that are located more than 40-feet from the building. The valves are provided with electric tamper switches.

Each main is provided with a fire department connection (FDC). The FDC’s are located on the south side of the building’s exterior wall. The closest hydrant is less than 400 feet from the FDC’s. The two 2 ½ inch outlets on the FDC’s conform to the National Standard Thread couplings standards. The piping between the FDC’s and the supply side of the alarm check valve assemblies is 4-inch. The FDC piping connects to the discharge side of the alarm check valves.

5.1.3 Sprinkler Systems

There is automatic sprinkler protection in the basement portion of the building; the remainder of the building is not sprinklered. A recommendation is being submitted to provide automatic sprinklers for the cable trays that go from the basement (HAI-07-901A-2) to the lab office area (FMR74-901A-7).

The alarm check valve assembly is a 6-inch Viking Model H-2, it is UL listed/FM approved and provides the required flow alarm activation to the building fire alarm panel. On the supply side of the alarm check valve is a 6-inch OS&Y control valve with an electronic tamper switch that is also monitored by the building fire alarm panel.

The wet-pipe sprinkler system in the mechanical space in the basement is hydraulically designed to provide 0.20 gpm per square foot over the most remote 2000 square feet. The demand for this system is 595 gpm at 49 psi.

5.1.4 Fire Standpipe Systems

One automatic wet standpipe system conforming to NFPA 14 is installed in this facility. The class of the standpipe systems, as listed in the BCNYS, is “Class II”. The hose valves are located in hose cabinets in the corridors and are not provided with hose or nozzles, which is the acceptable practice.

5.1.5 Other Suppression Systems

There are two Halon 1301 gaseous fire suppression systems in the building. Halon 1301 (bromotrifluoromethane, CBrF3) is a colorless, odorless, electrically nonconductive gas that is an effective medium for extinguishing fires. The systems protect the control room and the computer room located directly below the control room. The Halon cylinders are located in the mechanical room in the basement. There are four 90 pound cylinders for each room and four 18 pound cylinders for each sub-floor space. Release of Halon requires two rate of rise heat detection zones to be activated. An abort switch is located near the Ansul AutoPulse IQ-301 control panel.

Photographs #4 and #5– Halon 1301 System

5.2 Fire Alarm Systems

5.2.1 Building Fire Alarm System

The Building is provided with an automatic fire alarm system, refer to Section 5.3. The main fire alarm panel is a Thorne Multi Zone 20, Panel 91.

5.2.2 Site Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage using a fault tolerant server infrastructure based multiplexed Site Fire Alarm System. The system is an Andover Continuum; installed in 2005 (Andover is a part of Simplex Grinnell). The system complies with the requirements of NFPA 72 defined as a Style 6 Class “A” System.

Two mirrored servers are located in separate buildings. If the lead server fails the system automatically switches over to the working server. The Site Fire Alarm System operates on a fault tolerant high speed Ethernet infrastructure that utilizes network switches and fiber wiring between each of the major components.

The Site Fire Alarm System monitors fire alarm panels located throughout BNL by using the existing site telephone cable plant. RS232 signals are sent via full duplex line drivers. Each fire alarm panel has two channels connected to the Site Fire Alarm System. The panels are divided into 9 communication “loops.” It is currently monitoring 9,700 points. Response time from alarm at the panel to alarm indication at the Central Station is less than 82 seconds, which is within the 90 seconds allowed by NFPA 72.

The main console is at the Firehouse, Bldg. 599. This station monitors all fire alarm signals, trouble and communication status alarms. A satellite station is provided at Safeguards and Security, Bldg. 50, and receives only the fire alarm signals. If the Firehouse does not acknowledge an alarm within 90 seconds, the satellite station at Bldg. 50 will receive an audible indication to handle the alarm. A second satellite station is provided at AGS Main Control Room, Bldg. 911, and receives only the fire alarm signals from the RHIC/AGS accelerator buildings. A team of Collider-Accelerator Control Room operators and Health Physics Support personnel respond during accelerator operating times.

5.3 Automatic Detection Systems

The building is provided with heat and smoke detectors in the following areas:

Location	Detector Type(s)	Connected To	Coverage Type	Spacing Complies with NFPA 72
Control Room. & Computer Equipment Room.	P, I, R	Halon Control Panel	Room	Yes
Target Rms. 1,2,3,4	P, I, R	FACP	Room	Yes
Mechanical Rms.	R	Bldg 958 FACP	Room	No
Accelerator Rm. 1 & 2	P, I, R	FACP	Room	Yes
Offices, Conference, Miscellaneous Rooms	R	FACP	Room	Yes
Main Supply Air Duct(s)	I	FACP	Duct	Yes
Pit Areas Under Accelerators	R	FACP	Room	No

Symbols

F: Fixed Temperature Heat Detectors
FACP: Fire Alarm Control Panel
I: Ionization Smoke Detectors
P: Photoelectric Smoke Detectors
R: Rate of Rise Heat Detectors

5.4 Fire Extinguishers

Fire extinguishers are provided in the building. The location and placement of portable fire extinguishers is in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

5.5 Smoke Exhaust System

The building is not provided with a manual or automatic smoke exhaust system.

6.0 FIRE HAZARDS

Fire hazard potentials are classified into four major categories; Special Occupancies, Unique Fire Hazards, Housekeeping in Vital Areas, Building Materials, Exterior Exposure Hazards, Natural Phenomenon Hazard Exposure, Toxic Fire Potential, Biological Fire Potential, and Radiation Fire Potential. The following is an evaluation of Building 901A for each category.

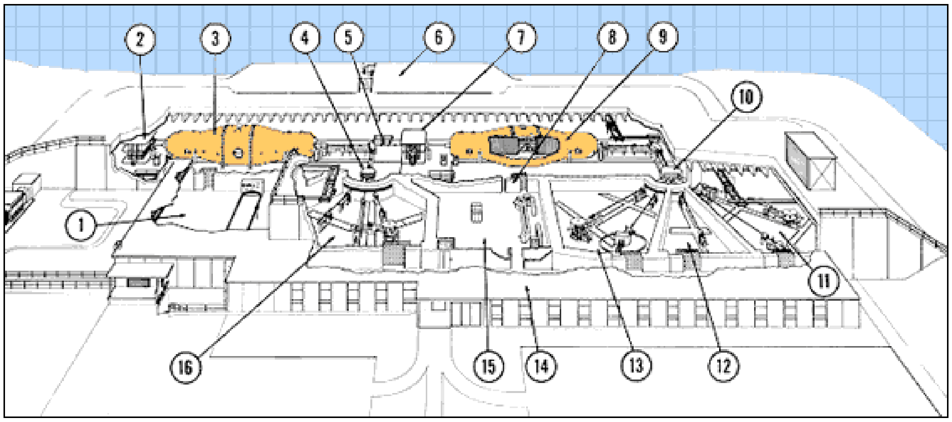
6.1 Special Occupancies

Special occupancies include: instrumentation and data processing equipment, vital and important records, trailers, cooling towers, electrical substations, flammable liquid and gas storage, cables and raceways. The special occupancies applicable to Building 901A are expanded upon in Sections 6.1.1 thru 6.1.7, below.

Sketch #1 is a cut-away view of the first floor of the Tandem Van de Graaff facility that show the two Van de Graaff electrostatic accelerators (3) and (9) each independently capable of accelerating a wide variety of ion species from external ion sources (2) and (7) through beam switching magnets (4) and (10) into target rooms (11), (12), (13) and (16). Highest particle energies are achieved in a three-stage operation with the first accelerator (3) injecting energetic negative ions through the connecting link (5) directly into the second accelerator (9). The accelerators are operated from the centrally located control room (15) which has direct access to the accelerator rooms through one of the shielding doors (8). The mechanical equipment room (1) contains the pumps and compressors necessary to transfer insulating gas from storage tanks (6) to each accelerator pressure vessel. Laboratory and office space (14) is available for resident and visiting scientific personnel.

The accelerators are about 100 feet long and 18 feet in maximum diameter. The accelerators are located in line in a room of fire resistive construction about 320 feet long by 35 feet wide. The room has a basement area used for the storage of spare equipment. Combustibles are limited.

Each accelerator contains 11,250 cubic feet of an insulating gas made-up of a 50/50 mixture of nitrogen and sulfur hexafluoride at about 150 psig surrounding the support column and accelerator tube, which is maintained at a high vacuum (13 atm of pressure). The injection voltages for the ion sources are developed for each unit by two insulated core transformers located in the basement area under the accelerators. The insulating gas is supplied by 79 tanks, each 80 feet long, buried in the earth cover above the units.



Sketch #1 – Tandem Van De Graaff's - Cut away view

Photograph #6– Tandem Van De Graaff's

The Target Rooms have several cable trenches about 24 inches deep by 3 feet wide equipped with metal encapsulated plywood covers. Each trench contains three cable trays stacked vertically plus utilities such as chilled water, compressed air. These trenches connect the experiment equipment and the Target Rooms with the Control Room. Each room's trench terminates into a metal cabinet about 2 ft. by 2 ft. by 5 ft. high that acts as a patch board between experiments and the control room. Combustibles in the trenches, except for the grouped cables, are limited.

The control room is located between Target Rooms 1 and 2. The room has a noncombustible raised floor used as a plenum with a large number of grouped cables. There is a fiberglass in steel frame suspended ceiling with no combustibles in this space.

There are four target rooms in the building:

Target Room No. 1

This room is not utilized as a target room at this time and contains a three ton bridge crane, mostly idle equipment and a small approved welding area. There is a target that is used as an ion source bench that is not tied to the accelerator.

Target Room No. 2

Target Room No. 2 contains a three ton bridge crane and configured with two exits at the main entrance to permit utilization of a large shielding door that is closed during experiments. This room is tired to the accelerators for local work and the testing of thin skin plastics for filter material (micro pour).

Target Room No. 3

Target Room No. 3 is used for the storage of electronic equipment and active power supplies that have AC as the primary and DC as the secondary.

Target Room No. 4

Target Room No. 4 is similar to Target Room No. 2 and is used for the testing of micro circuits. It also contains a three ton bridge crane.

Photograph #7 –Typical Target Room

The western portion of the first floor is occupied by equipment rooms and offices. The amount of combustibles in this area is limited.

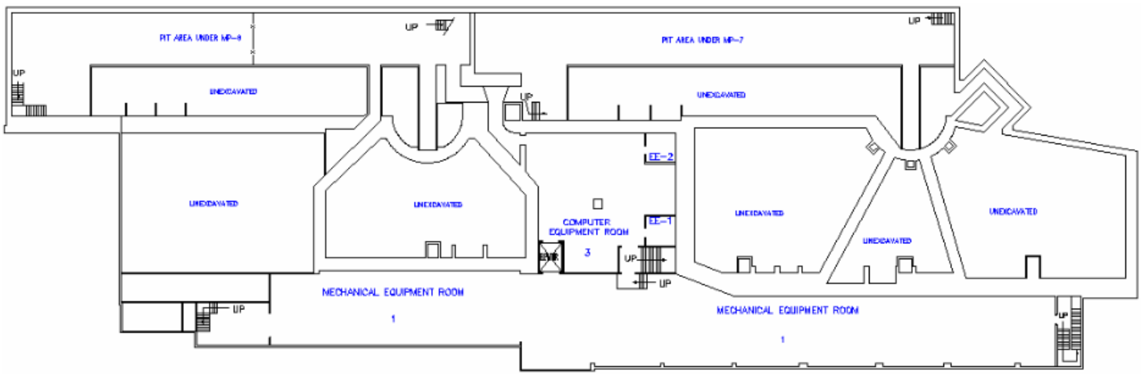
The southern portion of the first floor is occupied by offices and laboratories. The amount of combustibles in this area can be relatively high in the offices (paper, books, etc.). Laboratory No. 2 contains three vacuum evaporators and a small milling machine that is used for targets and foils.

In the basement is the Computer Equipment room which has a noncombustible raised floor used as a plenum with a large number of grouped cables. There is a fiberglass in steel frame suspended ceiling with no combustibles in this space.

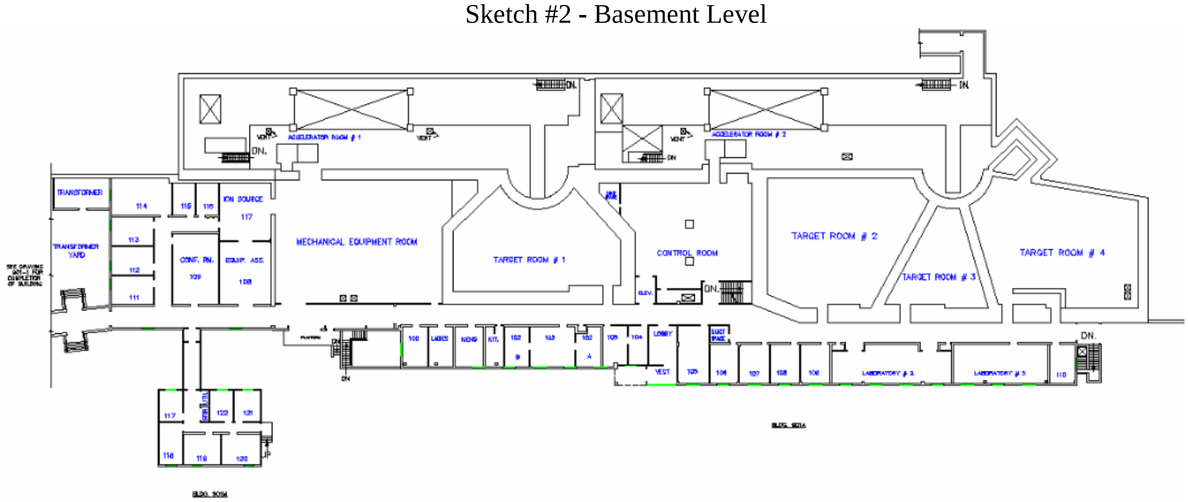
The mechanical room in the basement houses the air conditioning units and associated equipment, including two older Norwalk air compressors and a DI water system that utilizes two DI water pumps. All control cables to and from the Control Room pass through this area. They are mostly in open metal cable trays, arranged along the north wall stacked vertically up to 9 trays deep. Each tray contains many insulated control and electrical cables, including power cables up to 440 volts. Each tray has single bags of vermiculite to act as fire stops. These are located at 30 foot intervals along the trays (based on a former Factory Mutual recommendation). The trays pass through the egress stair between the basement and first floors to get to the Control Room.

Six Heating Ventilating and Air Conditioning (HVAC) zones exist for the building. HVAC zone "1" covers the office Area on the first floor. HVAC zone "2" covers the four Target Rooms (1-4). HVAC zone "3" covers the Computer Equipment Room in the basement and Control

Room on the first floor. HVAC zone “4” covers the Mechanical equipment room and electrical equipment room on the first floor. HVAC zone “6” covers the Accelerator Room 1 on the first floor. HVAC zone “7” covers the Accelerator Room 2 on the first floor. The equipment is located in the basement mechanical room.



Sketch #2 - Basement Level



Sketch #3 - First Floor

6.1.1 Instrumentation and Data Processing Equipment

DOE/EP-0108 established levels of protection for Instrumentation and Data Processing equipment and the facility in which it is housed. The facility contains moderate amounts of instrumentation and data processing equipment in the control room and computer room that is located directly below the control room. The installation is in compliance with DOE/EP-0108 for smoke detection and automatic fire suppression except that a fire door is needed between the control room and the accelerator room (See Recommendation HAI-07-901A-01).

Automatic Smoke Detection Protection

Computer equipment rooms or areas that exceed the $250,000 limit established by DOE require smoke detection. There is a single computer room and control room associated with Building 901A that are both provided with smoke detection.

Automatic Sprinkler Protection

Computer equipment rooms or areas that exceed the 1 million dollar value limit require sprinkler protection. There is a single computer room associated with the building that is provided with smoke detection and an automatic Halon 1301 system.

Fire Barriers

DOE requires fire barriers if the value of the structure and contents exceeds $50 million. No fire barriers are required by this DOE standard in this facility.

6.1.2 Vital and Important Records Storage

Vital records are those records which are essential to the mission of an important program and which, if lost, could not be reproduced or obtained elsewhere. Important records are those records possessing a high value to the mission of an important program but which, if lost, could be reproduced or reconstructed with difficulty or significant extra expense.

Based on the above definitions, there are no vital or important records in this facility.

6.1.3 Trailers and Portable Structures

Building 901M is a modular building connected by a hallway to Building 901A. There is a 1-1-1/2 hour rated fire door at the point of connection to Building 901A. The modular building is provided with smoke detection. It is located sufficiently distant (20 feet) from the building to not present a significant exposure hazard.

6.1.4 Cooling Towers

There is a prefabricated unit constructed of metal frame and walls with plastic fill. A fire in the cooling tower will not cause damage to the main building due to spatial separation, the non-combustible construction of Building 901A and the limited amount of combustibles in the tower.

6.1.5 Electrical Substations

The transformers and switchgear are arranged to comply with the recommendations contained in Factory Mutual Loss Prevention Data Sheet 5-4 for fire protection. The transformers do not present an exposure hazard to the facility or to each other.

The 1500 KVA transformer utilizes 550 gallons of a high flash point fluid. The 200 KVA transformer uses 550 gallons of a high flash point fluid. They are located in a containment system consisting of dikes and rock fill.

Photograph #8 Transformers

6.1.6 Flammable Liquid & Gas Storage

The use of flammable liquids in Building 901A is minimal. The quantity of flammable gases and liquids in the facility is less than the limits mandated by BCNYS Table 307.7(1) "*Maximum Allowable Quantity per Control Area of Hazardous Materials Posing a Physical Hazard*." Use of flammable liquids is in accordance with BNL ES&H Standards (found at https://sbms.bnl.gov/ld/ld08/ld08d481.pdf).

6.1.7 Cables and Raceways

High voltage, low voltage, control, and signaling cables are segregated throughout the building in accordance with NEC requirements. The cabling is located in conduits, raceways and cable trays. Most of the power and control cables and wiring in the building have Hypalon jacketing which has low-toxicity, low-smoke, and self-extinguishing ratings. The use of this jacketing will minimize fire propagation and smoke generation in the event of a fire. Polyvinyl

Chloride (PVC) and other flammable types of insulation and jacketing have been kept to a minimum, in accordance with the fire protection program.

Cable trays are easily accessible for manual fire fighting, most are from the basement to the first floor. Cable tray fires are not fast spreading. There is no specific early warning or fire suppression provided for the cable trays, thus the time to detection of a cable fire will be delayed, and will be off-set of automatic sprinkler are provided (see next paragraph). Recovery time to repair damaged cables is expected to be less than 3 months, as the extent of cable trays in Building 901A is not excessive.

However, the cable trays in the tunnel-like area between the accelerator room and the computer and control rooms present a special fire hazard due to the difficulty of accessing the area, thus a recommendation (HAI-07-901A-02) has been submitted to provide automatic sprinkler protection for the cable trays in this area.

6.2 Unique Fire Hazards

There are no unique hazards at this facility. There is no excessive use of combustible oils for cooling. Heat for the facility is via steam heat exchangers that receive steam from the BNL steam plant. The heat exchangers produce hot water.

The vacuum tech shop does not present any unique fire hazards. This shop repairs and maintains vacuum equipment and also tests this equipment. Most of the activity is bench work. There is an ion source tech shop that is also bench work that utilizes a small metal lathe, and has a small lab hood with a single flammable liquids cabinet.

6.3 Housekeeping in Vital Areas

Good housekeeping and control of combustibles was observed during this survey. The Collider-Accelerator department self-inspection program (Tier I) monitors routine experimental aspects. The BNL Plan Review Process screens conventional construction operations.

6.4 Building Materials

No exposed polystyrene insulation or other highly combustible building materials are used in the construction or operations at Building 901A. Therefore, no special fire protection precautions are required for this facility.

6.5 Exterior Exposure Hazards

Any exterior structure, area or piece of equipment that is subject to harmful effects from, or can cause harmful effects to this facility is defined as an exterior exposure. Exterior exposures can be categorized as elements outside of the facility, and as components of the facility.

There are no exterior fire exposures to Building 901A. Building 901M, which is integral to Building 901A, is connected via an enclosed hallway.

The following is a summary of the exposures to Building 901A:

North: Building 975 is over 300 feet from the building, and the building is at grade on this side.

South: Is a roadway that provides sufficient distance to any exposing buildings.

East: No significant exposures.

West: Exposed by Building 901.

6.6 Natural Phenomenon Hazard Exposure

Natural Hazards can be classified into five hazard categories: lightning, windstorm, wild fire, earthquake and flooding. The following is an evaluation for each category.

6.6.1 Lightning Potential

Based on NFPA standard 780 a lightning protection system is not required. Refer to Appendix B that shows that the expected lightning frequency (Nd) is **0.0057** and the tolerable lightning frequency (Nc) is **0.0060**. Based on NFPA 780, If Nd > Nc, a lightning protection system should be installed.

6.6.2 Windstorm Potential

The Long Island area basic wind speed (3-second gust) is 120 MPH based on Factory Mutual Data Sheet 1-28 and BCNYS Figure 1609.4. The ground roughness exposure category for the area is 'Exposure B." Based on the calculations this building should have roof assemblies classified as "Class 90" rated assemblies. Most of this facility is in a hillside.

6.6.3 Brush Fire Potential

Building 901A was not included in the "*BNL Wildland Fire Interface Survey Report,*" dated August 2002.

An analysis was completed consistent with the requirements and guidelines of NFPA 1144 *Protection of Life and Property from Wildfire* (2002) to determine the wildfire risk to Building 901A. The risk assessment was conducted in accordance with the Wildfire Hazard Severity Form checklist of NFPA 1144. The checklist is a summary of typical desirable characteristics found in various wildfire hazards analyses. Elements include emergency response ingress and egress, type of vegetation, topography, building construction and roofing materials, available fire protection, and utilities.

Based on the analysis, the hazard from wildfire to Building 901A is "LOW" (score of 30, with 40 being the cut-off for low hazard). Specifics of the Wildfire Hazard Severity Analysis are shown in Appendix C of this report.

6.6.4 Earthquake Potential

The seismic damage potential for this facility is classified as low based on a Natural Hazards Analysis produced for the BNL campus titled "*DOE Accelerator Order 5480.25 Implementation Plan for Brookhaven National Laboratory National Phenomena Hazards Evaluation*" dated April 1994. A low seismic classification means that the buildings and fire protection systems are not required to comply with seismic design standards.

6.6.5 Flooding Potential

Flood potential from bodies of water overflowing their normal levees is low for the BNL area. The flooding potential for this facility was classified as low in a Natural Hazards Analysis report produced for the BNL site, dated April 1994, titled "*DOE Accelerator Order 5480.25 Implementation Plan for Brookhaven National Laboratory National Phenomena Hazards Evaluation*."

Groundwater runoff from a severe rainstorm could be a concern for Building 901A due to the surrounding terrain. However, further evaluation is beyond the scope of this analysis.

6.7 Toxic Fire Potential

There are no known toxic materials present in the building that present a release potential due to fire. There were no identified PCB's within the building.

6.8 Biological Fire Potential

There are no known biological materials present in the building that present a release potential due to fire.

6.9 Radiation Fire Potential

There are no known radiological materials present in the building that present a release potential due to fire. By nature of the operations of the accelerators, various pieces of equipment can become activated. Since they are ion accelerators the levels are low. This activation is not expected to pose a significant environmental impact in the event of a fire since the material will not be easily disbursed.

7.0 PRE-FIRE AND EMERGENCY PLANNING

The BNL Fire Department maintains an adequate pre-fire plan book for this facility (http://intranet.bnl.gov/emergencyservices/runcards/main_i.asp). The pre-plan was reviewed as part of this analysis. A local emergency plan is maintained for the Tandem Van De Graaff complex. This plan includes control room operator actions to address the various alarms. Operator requirements are documented in the Collider-Accelerator Department Operation Procedure Manual.

7.1 Protection of Essential Safety Class Systems

There are no essential safety class systems associated with this non-nuclear facility.

7.2 Protection of Vital Programs

The operations associated with this facility are not considered to be a DOE vital program. Therefore, no special fire protection precautions, beyond those that are described in this report, are required for this facility.

7.3 Protection of High Value Property

High value equipment is generally regarded as any single item that is valued at $1 million or more, or where the loss of a single item could result in a loss of program continuity of greater than six months.

The two Van De Graaff generators/accelerators may meet this criterion. The exact value of this equipment could not be obtained, but could exceed $1M, refer to recommendation FMR74-901A-7.

7.4 Critical Process Equipment

By DOE standards, critical process equipment is considered to be equipment which, if lost or damaged in a fire, could delay a significant component of a major program for a period in excess of 6 months.

By the above definition, the Tandem Van De Graaff Generators/Accelerators meet this criterion and if lost would impact the operation of the AGS.

A recommendation has been submitted (HAI-07-901A-03) recommending a contingency plan be developed which outlines the steps required to reroute the beam line from the accelerator number 6 directly to the Tandem to Booster tunnel, thus bypassing accelerator number 7 completely. In addition, the contingency plan should address the work required to upgrade the performance of accelerator number 6 so that it is capable of independently providing particle beams to the RHIC program. The contingency plan should be capable of being implemented within six months, or at a time period acceptable to the Program Senior Official. If the six month conversion time (or time approved by the Program Senior Official) is not possible, consideration should be given to providing a permanent connection directly from accelerator number 6 to the Tandem to Booster tunnel and upgrading the performance capabilities of the accelerator. Completion of this recommendation will result in a series/parallel connection from the accelerators to the Tandem to Booster tunnel.

7.5 Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL)

The MPFL, as defined in DOE Order 420.1, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential, assuming the failure of both automatic fire suppression systems and manual fire fighting efforts. The fire loss estimate includes the replacement cost of equipment and property and any applicable decontamination and cleanup costs.

In accordance with the BNL Fire Safety Program, protection is required for facilities having an MPFL in excess of established thresholds as follows:

- When the MPFL exceeds $1 million an automatic sprinkler system designed in accordance with applicable NFPA standards is required;
- When the MPFL exceeds $25 million, a redundant fire protection system is required such that, despite the failure of the primary fire protection system, the loss will be limited to $25 million; and
- When the MPFL exceeds $50 million, a redundant fire protection system and a 3-hour fire resistance rated barrier are required to limit the MPFL to $50 million.

7.5.1 MPFL Scenario

The building is considered one fire area and thus a single MPFL calculation is being performed. The area selected is the area containing the two Van De Graaff generators that also contains support and control equipment. The amount and continuity of combustible material is low.

Combustible loading throughout the building could conservatively be sufficient to potentially reach flashover conditions for heat release rates and fire duration, especially in several offices and support areas. Flashover indicates that the temperature inside the area would be sufficiently hot to cause multiple fuel package ignitions within the space and result in loss of all contents. Associated compartment temperatures at flashover are generally accepted to be between 500°C (900°F) to 600°C (1100°F). Flashover is generally defined as the transition from a growing fire to a fully developed fire. Fully developed fires impose extensive thermal and physical stresses on fire barriers, the failure of which could lead to fire spread throughout the area. This comparison is conservative since the areas where the combustibles are located within the building represent a relatively large volume, making flashover unlikely (except in the offices), but possible, and only if there would be significant transient combustibles in any particular area (which would be a gross failure of the combustible loading program in these large spaces).

7.5.2 MPFL Calculation

The building has a replacement value of approximately $27,000,000 ($26,735,342). The building value was obtained from 2004 replacement costs. The average dollar density of the building is the replacement value divided by the floor area of the building $27,000,000/65,611 ft^2 = $412/ft^2.

The content and equipment value is calculated based on the following assumptions:

- An average of $20/ft^2 for content and equipment value within predominantly office areas, which does not apply to Building 901A.

- An average of $100/ft^2 for content and equipment value within the industrial and experimental areas of the building.
- There were no available replacement costs provided for the equipment within Building 901A. For the purposes of this FHA the value is assumed to be approximately $10,000,000, based on the uniqueness of the Tandem Van De Graaff Generators and associated power supplies and electrical equipment.

Based on the lack of continuity of combustibles within the high bay and the massive size of the Van De Graaff generators, it is not likely that a single MPFL fire would totally destroy both generators, thus for the purposes of this MPFL calculation, 50% of the generators would be damaged in a severe fire. Additionally a single MPFL fire is not likely to destroy the entire building, thus for the purposes of this MPFL calculation, it is assumed that 60% of the building would be significantly damaged which equates to $16,200,000.

MPFL Summary

Attribute	Value
Building Value	$16,200,000
Contents	$5,000,000
MPFL Total	$21, 200,000

7.5.3 MCFL Scenario

The MCFL, as defined in DOE Standard 1066-99 Fire Protection Criteria, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential. This assumes that all installed fire protection systems function as designed, and the effect of emergency response is omitted except for post-fire actions.

For Building 901A, there is limited automatic sprinklers, thus for the MCFL calculation, the building is assumed to be unsprinklered, especially since the MPFL calculation was for the first floor which is not protected with automatic sprinklers.

Without sprinkler protection the MCFL is the same as the postulated MPFL for that area.

MCFL Summary

Attribute	Value
Building Value	$16,200,000
Contents	$5,000,000
MCFL Total	$21, 200,000

7.5.4 MPFL/MCFL Summary

Fire Area	MPFL	MCFL
Building 901A	$21,200,000	$21,200,000

7.6 Recovery Potential

Critical process parts have been identified by the Department. Critical process parts are those items essential to the operations of the facility that require a long lead-time for replacement. Recovery potential is based on the ability to produce and replace electronic equipment and the various power supplies. For Building 901A, the Tandem Van De Graaff generators/accelerators are critical, long lead time equipment. Without this equipment the AGS could not operate.

7.7 BNL Fire/Rescue Group

The BNL Fire/Rescue Group is a full time, paid department. Minimum staffing is five firefighters and one officer per shift. The firefighters are trained to meet Firefighter Level III by International Fire Service Training Association standard, National Fire Protection Association (NFPA) Fire Fighter Level II standard, and (NFPA) Hazardous Material Technician Level and they are Suffolk County Certified Confined Space Rescuers.

The BNL Fire/Rescue Group also provides emergency medical services to an on-site population of 3200 people. A minimum of two members per shift hold New York State “Emergency Medical Technician - D” certifications (“D” is for defibrillation). Normally all five firefighters have EMT status. The Group operates a New York State Certified Basic Life Support ambulance. Medivac services are available to BNL via the Suffolk County Police Department. Additionally the Fire/Rescue Group has two 1500 GPM "Class A" Pumpers, one Rescue Vehicle for initial hazardous material incident response and heavy rescue operation, and one Incident Command Vehicle.

The single Fire Station is located on the west side of the BNL Site. Response time to the most remote section of the BNL Site is less than eight minutes. Response time to Building 901A is estimated at 5 minutes or less.

BNL participates in the Suffolk County Mutual Aid Agreement. This allows the resources from over 130 departments to assist BNL. BNL is also a member of the Town of Brookhaven Foam Bank. BNL has a mutual aid agreement for hazardous material incidents with the Town of Brookhaven and Stonybrook University.

7.8 Fire Apparatus Accessibility

Fire apparatus accessibility is adequate for the facility. Current parking lot configurations allow access by apparatus in the event of an emergency. Roadways are located on the south side of the building (as the building is built into a hill).

7.9 Security Considerations Related to Fire Protection

The facility has limited security measures that restrict access (locked doors). Provisions have been made for Fire/Rescue access via provision of master keys.

8.0 LIFE SAFETY CONSIDERATIONS

Life safety considerations for this facility include means of egress consisting of exit access, exits and exit discharge, exit signage, and emergency lighting. This building is required to comply with the state building code and NFPA 101®, the Life Safety Code (LSC). The requirements of both the 2002 edition of the Building Code of New York State (BCNYS) and the 2006 edition of the LSC have been applied to this analysis. It should be noted that the BCNYS is not intended to apply to existing structures. Appendix K of the BCNYS addresses alterations to existing structures. This building was likely constructed to comply with the version of the Life Safety Code NFPA 101 in effect at the time of construction; 1969. DOE now requires all buildings to conform to local building codes and NFPA 101.

8.1 Occupancy Load Factor and Calculations

Occupancy load factor and calculations

The following table summarizes the occupant load calculations based on both the BCNYS Table 1003.2.2.2 and NFPA 101 Table 7.3.1.2. An occupant load factor of 300 sq ft per person was applied to special-purpose industrial and mechanical/electrical equipment areas and 100 square feet for a Business occupancy. Factors for these spaces are not specified in the LSC.

Table 8.1-1
Occupant Load Calculation

Location	**Occupancy Load Factor (per person)**		**Area (feet)**	**Occupant Load Calculations**	
	BCNYS	NFPA		BCNYS	NFPA
Building 901A	100 gross	300/100 gross	65,611	657	219/657
TOTAL			65,611	657	219/657

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The total building occupant load for code compliance purposes is 657 occupants based on the BCNYS or 219 per the NFPA 101 for special purpose occupancy and 657 for a business occupancy. This occupant load exceeds the probable actual number of occupants. The building is occupied routinely throughout the day by generally less than 75 personnel. The maximum occupancy is estimated to not exceed 125 under most normal activities, including visitors for experiments.

8.2 Means of Egress

The means of egress for the building meets the present code requirements for number and arrangement of exits, capacity of exits, travel distance, common path of travel, dead ends, and security considerations related to egress. The following subsections discusses each of the elements.

8.2.1 Number and Arrangement of Exits

The LSC requires that a floor with an occupant load of 500 or fewer persons must have a minimum of two means of egress [§7.4.1.1]. Additional exits may be required for compliance with exit capacity or arrangement of exits criteria.

The Mechanical Equipment Room in the basement has two 36 inch clear width doors on the west side of the building leading to an exterior unenclosed stair. The same room also has two 36 inch clear width doors on the east side of the building leading to an exterior unenclosed stair.

An unenclosed egress stair is located in the middle of the building provides 36 inch clear width between the basement and the 1st Floor (into the high bay where the Tandem Van De Graaff generators are located).

The 1st floor has a total of nine doors leading to either the exterior of the building or into other buildings. All of the doors have a clear width of 36 inches. On the extreme west side of the building are two fire doors leading into Building 901. On the west side opposite the transformer yard are two doors leading to the outside. The loading dock on the west side has one door leading to the outside. Building 901M has a door leading to the outside. The lobby in the center of the building has a door leading out of the building. On the east side of the building are two doors leading to the outside.

8.2.2 Capacity of Exits

The egress capacity provided from a floor or portion thereof must be sufficient to accommodate the occupant load. The egress capacity for an egress component is based on the width of the component. For stairways, the factor of 0.3 in. of stair width per person is applied. For doors, ramps, corridors, and other level components, the factor of 0.2 in. of width per person is applied.

Street floor exits (i.e., First Floor) must be sufficient for the occupant load of the street floor plus the required capacity of stairs discharging through the street floor [LSC §40.2.3.3]. The building meets this criterion.

The available exit capacity of Building 901A exceeds the occupant load based on the BCNYS (Table 1003.2.3) and NFPA 101 (Table 7.3.3.1) for stairways and other egress components in a non-sprinklered facility.

8.2.3 Travel Distance

Building 901A egress paths do not exceed the BCNYS and NFPA 101 travel distance limitations. BCNYS (Table 1004.2.4) limits egress travel distance to 300 feet in this type of unsprinklered F-2 occupancy. NFPA 101 (Table 40.2.6 and Section 40.2.6.3) limits egress travel distance to 300 feet in this type of unsprinklered Industrial Special Purpose occupancy, and 200 feet for an unsprinklered business occupancy §39.2.6.2.

8.2.4 Common Path of Travel

The building meets the common path of travel criteria found in Section 40.2.5.3 in the Life Safety Code. Since the building is not protected with automatic sprinklers the allowable common path of travel is 50 feet for a special purpose occupancy and 75 feet for a business occupancy (§39.2.5.3.3).

8.2.5 Dead Ends

Per Section 40.2.5.2 (industrial occupancy) and 39.2.5.2 (business occupancy) of the Life Safety Code, and the Fire Code of New York State (FCNYS) (Table 1010.17.2) a dead end corridor cannot exceed 50 feet. The building is in compliance with these criteria.

8.2.6 Security Considerations Related to Fire Protection

The building does not have special access controls that restrict egress or fire rescue ingress.

8.2.7 Separation of Means of Egress

Where two exits or exit access doors are required, they must be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area served [LSC §7.5.1.3.2; BCNYS §]. The building is provided with primary exits that meet this requirement.

8.3 Exit Signs and Emergency Lighting

Exit signage is required in accordance with Section 7.10 of the LSC. Exit signs should be placed in corridors and in rooms required to have at least two means of egress. Internally-illuminated exit signs and exit placards are provided in the building.

Emergency lighting for means of egress is required in accordance with Section 7.9 of the LSC. Emergency lighting is required in industrial occupancies [§40.2.9.1] except special-purpose industrial occupancies without routine human habitation. Emergency lighting modules with battery packs are provided on a limited basis in the building.

8.4 Emergency Roof Exits

A means of escape is defined as a way out of a building or structure that does not conform to the strict definition of means of egress but does provide an alternate way out [LSC §3.3.152]. The building has no such arrangement.

8.5 Egress through Adjoining/Intervening Spaces

Exit access from rooms or spaces is permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served and the intervening rooms or areas are not spaces identified under Protection from Hazards (e.g., storage rooms)

[LSC §7.5.1.6]. The building complies with this requirement. Intervening rooms through which required egress occurs are accessory and not a higher hazard to the area served.

8.6 Exit Discharge

Exits are required to terminate directly at a public way or at an exterior exit discharge. The LSC permits a maximum of 50 percent of the required number of exits to discharge inside the building provided the level of discharge is fully-sprinklered or the area of discharge is sprinklered and separated from the remainder of the building by fire barriers [§7.7.2.2; §7.7.2.4]. The criterion does not apply to Building 901A.

8.7 Horizontal Sliding Doors

Approved, existing horizontal-sliding or vertical-rolling fire doors are permitted in means of egress under the following conditions [LSC §40.2.2.2.4]:

- They are held open by fusible links.
- The fusible links are rated at not less than 165°F.
- The fusible links are located not more than 10 ft above the door.
- The fusible links are in immediate proximity to the door opening.
- The fusible links are not located above a ceiling.
- The door is not credited with providing any protection for life safety purposes (i.e., property protection only).

There are no horizontal exit doors utilized in Building 901A. There is a horizontal fire door located at the AGS tunnel entrance that is located at the northeast corner of the high bay. The use of this path is not a credited exit path, thus its presence is not a life safety concern.

8.8 Fire Escape Ladders

Fire escape ladders complying with 7.2.9 are permitted in industrial and business occupancies [§40.2.2.10; §39.2.2.10]. Fire escape ladders are permitted as means of egress only where one of the following conditions exists:

- Access to unoccupied roof spaces as permitted by 7.2.8.3.4.
- Secondary means of egress from boiler rooms or similar spaces subject to occupancy not to exceed three persons who are all capable of using the ladder.
- Means of egress from towers and elevated platforms around machinery or similar spaces subject to occupancy not to exceed three persons who are all capable of using the ladder.

Fire escape ladders are not provided in the building.

8.9 Door Heights

Means of egress are required to provide a headroom clearance of not less than 6 ft 8 in. at doorways [LSC §7.1.5.1]. The existing doors meet this requirement.

8.10 Discharge to Roofs

Exits are permitted to discharge to roofs or other sections of the building where the following criteria are met and with approval by the authority having jurisdiction [LSC §7.7.6]:

- The roof/ceiling assembly construction has a fire-resistance rating not less than that required for the exit enclosure.
- A continuous and safe means of egress from the roof is available.

There are no exits to the roof in this building that is built into the side of a hill.

8.11 Barriers

8.11.1 Occupancy Separations

Occupancy separations are not required for Building 901A since there is a single occupancy for the building.

8.11.2 Incidental Use Areas

Incidental use areas or hazardous areas are considered those spaces that pose a relatively higher hazard than the predominant occupancy of the area in which they are located. Such spaces are not necessarily classified as high-hazard (Group H) occupancies. Hazardous areas include general storage rooms, boiler or furnace rooms, and maintenance shops. The LSC requires hazardous areas to be separated from adjoining areas by a 1-hour fire resistance-rated barrier without windows or protected by automatic fire suppression systems [LSC §8.7.1.1]. Rooms with severe hazards such as maintenance shops with woodworking and painting are required to have both fire barrier enclosure and automatic fire suppression.

There are no such rooms associated with Building 901A.

8.11.3 Separation of Means of Egress

The exits within the building are well separated and meet the separation criteria within NFPA 101.

8.11.4 Exit Access Corridors

Exit access corridor walls are typically constructed of concrete masonry and extend from the floor to the underside of the floor slab above. Fire resistance-rated corridor walls are not required in existing industrial occupancies [LSC §40.3.6].

The BCNYS requires exit access corridors serving a Group F occupancy in non- or partially-sprinklered buildings to be enclosed with 1-hour fire partitions [BCNYS Table 1004.3.2.1].

There are no exit access corridors in Building 901A, thus this criterion does not apply.

8.11.5 Vertical Opening Barriers

Not applicable to Building 901A.

8.11.6 Egress Stairways

Vertical openings, including stairways, are required to be enclosed with fire-resistive construction to limit fire and smoke spread to other floors.

Vertical openings must be enclosed or protected in accordance with LSC Section §8.6 unless otherwise permitted by the following [§40.3.1]:

1. Unenclosed vertical openings in accordance with 8.6.8.2 shall be permitted.
2. Exit access stairs shall be permitted to be unenclosed in two-story, single-tenant spaces that are provided with a single exit in accordance with §39.2.4.2(5).
3. Unprotected vertical openings shall be permitted in buildings complying with all of the following:

   a. Where protected throughout by an approved automatic sprinkler system in accordance with §9.7.1.1(1);
   b. Where no unprotected vertical opening serves as any part of any required means of egress; and
   c. Where required exits consist of exit doors that discharge directly to grade in accordance with §7.2.1, outside stairs in accordance with §7.2.2, smokeproof enclosures in accordance with §7.2.3, or horizontal exits in accordance with §7.2.4.

The there are no protected egress stairways for Building 901A.

8.12 Fire Protection Systems Required by Code

Automatic sprinkler protection is not required to address life safety conditions found in the building.

8.13 Operational Requirements that are Required by Code

When performed, cutting and welding operations in the building are required to be conducted in accordance with NFPA 51B**,** *Standard for Fire Prevention during Welding, Cutting, and Other Hot Work*, 2003 Edition.

There are no other fire protection related operational requirements required by code, there is an approved welding area in Target Room No. 1

9.0 REFERENCE DOCUMENTS

9.1 National Fire Protection Association

NFPA 10, *Standard for Portable Fire Extinguishers*, 2002 Edition

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2002 Edition

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 Edition

NFPA 51B**,** *Standard for Fire Prevention during Welding, Cutting, and Other Hot Work*, 2003 Edition

NFPA 70, *National Electrical Code*®, 2005 Edition

NFPA 72®, *National Fire Alarm Code*®, 2002 Edition

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2002 Edition

NFPA 101®, *Life Safety Code*®, 2006 Edition

NFPA 220, Standard on *Types of Building Construction*

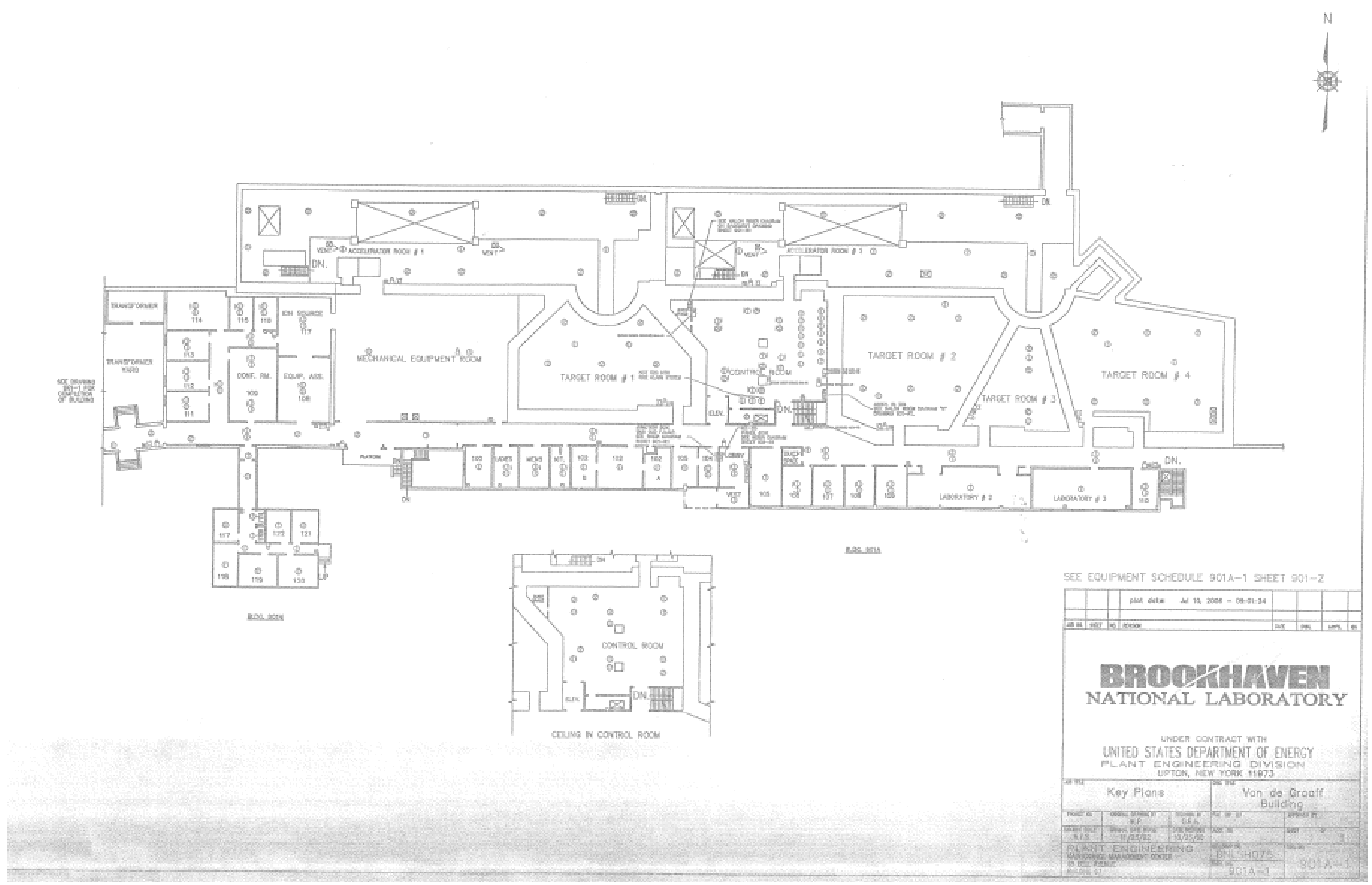
NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2004 Edition

NFPA 1144, *Standard for Protection of Life and Property from Wildfire*, 2002 Edition

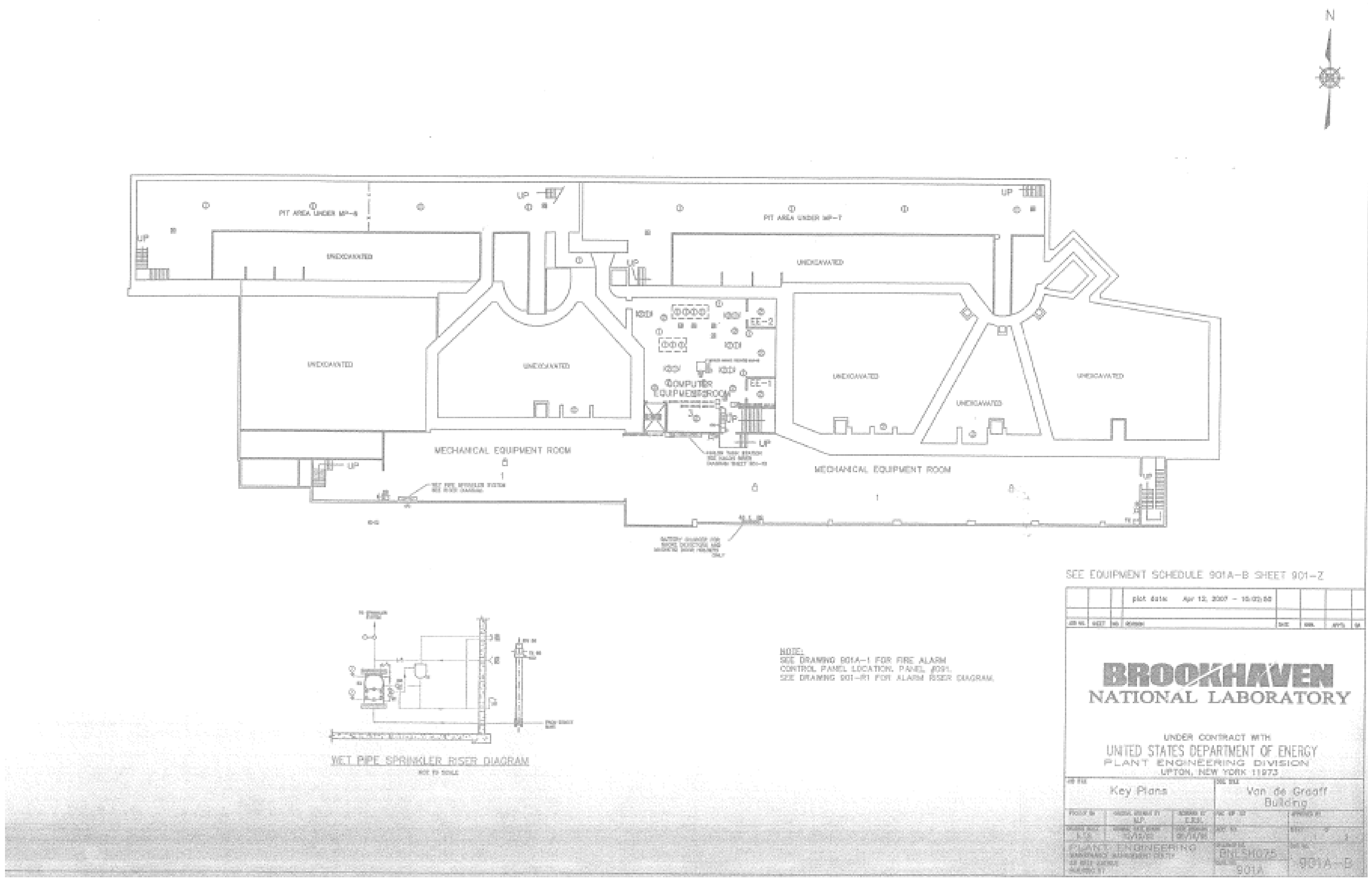
9.2 FM Global Loss Prevention Data Sheets

None.

APPENDIX A – FHA FIGURES



Building 901A – First Floor



Building 901A – Basement

APPENDIX B –

LIGHTNING RISK CALCULATION

The expected lightning frequency (Nd) is **0.0057** and the tolerable lightning frequency (Nc) is **0.0060**. Based on NFPA 780, If Nd > Nc, a lightning protection system should be installed.

EXPECTED LIGHTNING STROKE FREQUENCY FROM NFPA 780 ANNEX L

$$N_d = (N_g)(A_e)(C_1)(10^{-6})$$

N_d = **0.0057** = yearly average flash density in the region where the structure is located

(N_g) = **2.0** = the yearly lightning strike frequency to the structure

(C_1) = **0.25** = the environmental coefficient

(A_e) = **11,363** = the equivalent collective area of the structure in square meters from calculation below

Length (L)	**450**	Feet
Width (W)	**100**	Feet
Height (H)	**20**	Feet
	0.25	

Figure H.4.2(a) Results 11,363 sq. meters

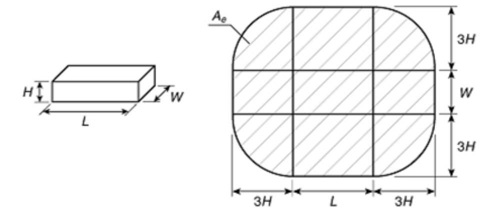
Figure H.4.2(b) Results 1,051 sq. meters

Table H.4.3 Determination of Environmental Coefficient C_1

Relative Structure Location	C_1
Structure located within a space containing structures or trees of the same height or taller within a distance of 3*H*	0.25
Structure surrounded by smaller structures within a distance of 3*H*	0.5
Isolated structure, no other structures located within a distance of 3*H*	1
Isolated structure on a hilltop	2

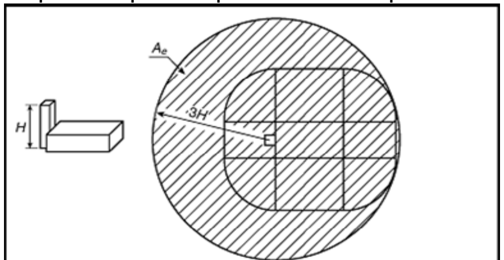
Assume
0.25

Figure H.4.2(a) Calculation of the equivalent collective area for a rectangular structure.



For a rectangular structure, $A_e = LW + 6H(L + W) + \pi 9H^2$.

Figure H.4.2(b) Calculation of the equivalent collective area for a structure where a prominent part encompasses all portions of the lower part of the structure.



Note: For a structure where a prominent part encompasses all portions of the lower part, $A_e = \pi 9H^2$

= input required

TOLERABLE LIGHTNING FREQUENCY FROM NFPA 780 APPENDIX L

N_c = **0.0003**

$$N_c = \frac{1.5 \times 10^{-3}}{C}$$

where $C = (C_2)(C_3)(C_4)(C_5)$.

Assume **0.5**

C_2 — Structural Coefficients			
	Roof		
Structure	Metal	Nonmetallic	Flammable
Metal	0.5	1.0	2.0
Nonmetallic	1.0	1.0	2.5
Flammable	2.0	2.5	3.0

Assume **2.0**

Structure Contents	C_3
Low value and nonflammable	0.5
Standard value and nonflammable	1.0
High value, moderate flammability	2.0
Exceptional value, flammable, computer or electronics	3.0
Exceptional value, irreplaceable cultural items	4.0

Assume **1.0**

Structure Occupancy	C_4
Unoccupied	0.5
Normally Occupied	1.0
Difficult to evacuate or risk of panic	3.0

Assume **5.0**

Lightning Consequence	C_5
Continuity of facility services not required, no environmental impact	1.0
Continuity of facility services required, no environmental impact	5.0
Consequences to the environment	10.0

= input required

APPENDIX C – Determination of Wildfire Hazard Severity

Using NFPA 1144

WILDLAND FIRE RISK AND HAZARD SEVERITY ASSESSMENT FORM
Appendix A, Figure A.4.2 from NFPA 1144

			ELEMENT	POINTS
A.			**Means of Access**	
	1.		Ingress and egress	
		a.	Two or more roads in/out	**0**√
		b.	One road in/out	7
	2.		Road width	
		a.	>= 24 ft	0
		b.	>= 20 ft and < 24 ft	**2**√
		c.	< 20 ft	4
	3.		All-season road condition	
		a.	Surfaced road, grade <5%	**0**√
		b.	Surfaced road, grade > 5%	2
		c.	Non-surface road, grade < 5%	2
		d.	Non-surface road, grade > 5%	5
		e.	Other than all-season	7
	4.		Fire Service Access	
		a.	<= 300 ft with turnaround	**0**√
		b.	> 300 ft with turnaround	2
		c.	< 300 ft with no turnaround	4
		d.	>= 300 ft with no turnaround	5
	5.		Street Signs	
		a.	Present	**0**√
		b.	Not present	5
B.			**Vegetation (Fuel Models)**	
	1.		Characteristics of predominate vegetation within 300 ft.	
		a.	Light (e.g., grasses, forbs, sawgrassess, and tundra) NFDRS Fuel Models A,C,L,N,S, and T	5
		b.	Medium (e.g. light brush and small trees) NFDRS Fuel Models D,E,F,H,P,Q, and U	**10**√
		c.	Heavy (e.g. dense brush, timber, and hardwoods) NFDRS Fuel Models B,G, and O	20
		d.	Slash (e.g. timber harvesting residue) NFDRS Fuel Models J,K, and L	25
	2.		Defensible space	
		a.	More than 100 ft of vegetation treatment from the structures	1
		b.	71 ft to 100 ft of vegetation treatment from the structures	3
		c.	30 ft to 70 ft of vegetation treatment from the structures	**10**√
		d.	< 30 ft of vegetation treatment from the structures	25

C. Topography Within 300 of Structures

1. Slope < 9%	**1**√
2. Slope 10% to 20 %	4
3. Slope 21% to 30%	7
4. Slope 31% to 40%	8
5. Slope > 41%	10

D. Additional Rating Factors

1. Topographical features that adversely affect wildland fire behavior	0-5 [**0**√]
2. Areas with a history of higher fire occurrence than surrounding areas due to special situations	0-5 [**0**√]
3. Areas that are periodically exposed to unusually severe fire weather and strong dry winds.	0-5 [**0**√]
4. Separation of adjacent structures that can contribute to fire spread	0-5 [**0**√]

E. Roofing Assembly

1. Class A roof	0√
2. Class B roof	**3**
3. Class C roof	15
4. Nonrated	25

F. Building Construction

1. Materials	
a. Noncombustible/fire-resistive siding, eaves, and deck	**0**√
b. Noncombustible/fire-resistive siding and combustible deck	5
c. Combustible siding and deck	10
2. Building setback relative to slopes of 30% or more	
a. >= 30 ft to slope	1√
b. < 30 ft to slope	5

G. Available Fire Protection

1. Water source availability	
a. Pressurized water source availability	
500 gpm hydrants <= 1000ft apart	**0**√
250 gpm hydrants <= 1000ft apart	1
b. Nonpressurized water source availability	
>= 250 gpm continuous for 2 hours	3
< 250 gpm continuous for 2 hours	5
c. Water unavailable	10
2. Organized response resources	
a. Station <= 5 miles from structure	**1**√
b. Station > 5 miles from structure	3

3. Fixed fire protection	
a. NFPA 13	**0**
b. None	5√ (partial, basement only)
H. Placement of Gas and Electric Utilities	
1. Both underground	**0**√
2. One underground, one aboveground	3
3. Both aboveground	5
I. Total	**30**

Hazard Assessment	Total Points
Low hazard	**< 40**
Moderate hazard	40-69
High hazard	70-112
Extreme hazard	> 112

A Wildfire Severity Level of 30 = A **LOW** Hazard